

VISUAL PROBLEMS CONCERNING LANDING ACCIDENTS

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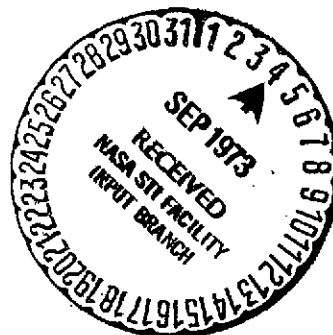
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## VISUAL PROBLEMS CONCERNING LANDING ACCIDENTS

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### I. Trends in Landing Accidents

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When aircraft accidents are classified by their time of occurrence, it is noteworthy that landing accidents occur with a much higher frequency than accidents during takeoff (Table 1). This may be said to be an indication of the danger of landing operations.

Phase of operation	Number	Per cent
Engine running	10	2 %
Taxiing	19	3 %
Take off	80	14 %
In flight	260	45 %
Landing	195	34 %
Go around	15	3 %
Total	579	

The most frequent causes of landing accidents are errors of the pilots themselves (Table 2). When landing accidents caused by the pilots are classified according to their types, the results shown in Table 3 are obtained. The most frequent are accidents in which the plane was landed short of the runway (undershoot); 17 such cases are listed. In one of these cases it is known that there was throttle trouble, and in one other case there was insufficient fuel. However, all the other accidents occurred in a normal operating state.

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\*Numbers in the margin indicate pagination in the foreign text.

Causative agency	Number	Per cent
Pilot	86	44 %
Other personnel	27	14 %
Material failure	66	34 %
Miscellaneous	7	4 %
Undetermined	9	5 %
Total	195	

Landed short (Undershoot)	17
Gear up or retracted after touchdown	14
Bounced or poor landing	11
Lost control on approach	10
Lost control on rollout	7
Failed to execute missed approach	4
Drag chute failure	4
Blew tire	4
Went off end (Overshoot)	3
Descended below minimums	2
Crashed on emergency landing	2
Adverse winds	2
Asymmetrical reversing	1
Miscellaneous	5

A type of accident which contrasts with undershoot is overshoot. This refers to cases when the plane landed too far off and went outside the runway. The number of cases of overshoot, as is shown in Table 3, is much less than the number of cases of undershoot.

In Table 4, the occurrence of undershoot and overshoot accidents is compared for daytime and nighttime. There is a larger percentage of undershoot accidents occurring at night. /71

Among the causes of undershoot accidents, the ratio occupied by errors of the pilot is even greater than that in ordinary landing accidents (Table 5). If we also include errors of instructor pilots, this amounts to 78% of the causes.

	Undershoot accidents		Overshoot accidents	
	Number	Per cent	Number	Per cent
Day	89	71 %	24	85 %
Night	36	29 %	4	15 %
Total	125	100 %	28	100 %

Causative agency	Number	Per cent
Pilot error in control	86	62 %
Instructor pilot error	21	16 %
Material failure	13	10 %
Maintenance	1	
Air base	3	
Weather	2	
Undetermined	2	
Total	128	100 %

Table 6 lists the pilot experiences of pilots involved in accidents. Many undershoot accidents occur even with highly experienced pilots with more than 1,000 total pilot hours. This fact indicates that the presence of human factors which may cause /72 undershoot accidents is not confined only to inexperienced pilots.

Total pilot hours	Number
0- 499	19
500- 999	13
1,000-1,999	27
2,000-4,999	55
5,000 and above	8
Total	122

In Table 7, the understood accident rate is compared by aircraft type. It is noteworthy that among cargo planes, jet cargoes have a higher rate of incidence.

Type of aircraft	Rate/10,000 landings
Fighter	.12. 4
Jet bomber	7. 0
Non-jet cargo	2. 5
Jet cargo	7. 6
Jet trainer	4. 5

From the data given above, one may say that, among landing accidents, the greatest need for concern is the occurrence of undershoot accidents caused by the pilot himself.

## II. Visual Problems Impeding Landing

In order for the pilot to touch the plane to the ground at a suitable place on the runway, it is necessary for him to follow the correct course in his approach and descent. At the final stage, the pilot does not have sufficient time to check the instruments. Furthermore, barometric altimeters do not have a great enough precision to indicate such low altitudes correctly. Thus, the reception and judgement of visual information collected by the pilot himself becomes important.

During the daytime, when there is good visibility, not only the runway but also the surrounding topography and structures enter into the pilot's field of vision, and he can therefore judge with relative ease whether the plane is following the correct course in its approach and descent.

As the visibility deteriorates, the visual reference points become gradually fewer and fewer. Furthermore, as the pilot approaches the terrain surface, the runway comes to occupy the greater part of his field of vision. In the final analysis, it is believed that the pilot comes to form a dynamic judgement of the relative positions (between the aircraft and the runway according to the changing appearance of the runway as a whole, centering around the anticipated point of touchdown [15].

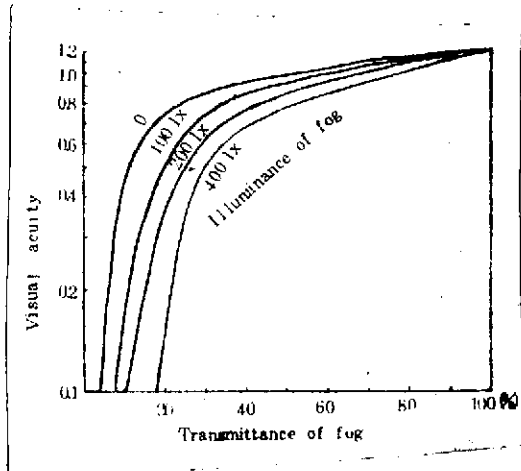
In this case, the following visual obstacles or optical illusions may be mentioned as possible factors impeding the pilot's judgement or leading him into misjudgements.

1. Decline of visibility on account of fog.

When there is fog in the atmosphere, it becomes more difficult to sight objects through the fog.

When one is sighting an illuminated object through dark smog, its degree of visibility declines gradually as the fog becomes thicker and drops rapidly when the transmittance of the fog drops 73 below 20%.

If we suppose that the intensity of illumination of the object is 200 lx and express its degree of visibility in terms of visual acuity values, as is shown in Fig. 1, there will be a value of 1.2 when there is no fog. However, at a transmittance of 20%, this will drop to 0.75, which is regarded as the limit of clear vision; and at a transmittance of 10%, it will drop below 0.5 [6].



## 2. Decline of visibility on account of veiling glare of fog.

When a plane is landed at night, the usual practice is for landing lights to be turned on so that the plane will descend towards the illuminated runway. When fog is present in the atmosphere at this time, the lights will undergo scrambling reflection on account of the fog, causing veiling glare, and the visibility will become even worse.

As in the preceding section, let us suppose that an object having an intensity of illumination of 200 lx is sighted through a fog. If the transmittance of the fog is 20%, the visibility will drop suddenly as the lighting is intensified towards the fog. That is, whereas the visual acuity would have been 0.75 in the dark, it will be 0.5 at an intensity of illumination of 100 lx in the fog; it will be 0.4 at 200 lx; and it will be less than 0.2 at 400 lx (Fig. 1) [6].

## 3. Obstacles caused by presence of smog layers.

When a layer of smog is present near the terrain surface, the aircraft will have to pass through this layer in the final stage of the landing approach.

When entering a smog layer, the pilot's vision is abruptly impaired. If the pilot enters such a state during approach with precision instruments, as soon as he comes out of the smog layer and the runway becomes visible to him, he will tend to

shut off the output and attempt to descend at a glide pass [7].

In the Air Self-Defense Force, a serious accident occurred in a case of undershooting because of impaired vision on account of layers of smog. In this accident, the plane in question had approached along the ordinary course of descent up to a distance of about 2 miles from the end of the runway. After entering the thick smog layer which was present to an altitude of about 300 feet above the ground, the plane rapidly lost altitude and flew along very close to the ground. After striking against power lines, it touched the ground about 1000 feet in front of the runway and was destroyed. The pilot was killed.

#### 4. Obstacles caused by rain on the windshield.

When raindrops are deposited on the windshield in front of the pilot's seat, the shapes of objects seen through the windshield become distorted. The degree of visibility declines as a result.

When viewed through a windshield moistened by rain, a runway will appear to be farther away and lower than it really is. Therefore, it is held that the pilot himself may form a mistaken judgement in the belief that his altitude is too high [8, 12].

#### 5. Misjudgement of distance with altitude.

The sense of perspective also will vary depending upon the altitude from which an object is viewed. When approaching for a landing, even though the horizontal distance from the end of the runway will be the same, the runway will seem to be farther when the altitude is higher or to be nearer when the altitude is lower. There is danger of undershooting or overshooting when the pilot does not notice this illusion or when he is

excessively conscious of it [8].

6. Illusions of altitude accompanying changes in intensity of illumination.

At night, everything on the ground is hidden by darkness, and the pilot will judge the altitude and perform the landing operations using ground illumination as his points of reference. The changes in intensity of the illumination perceived by the pilot at this time are sometimes misinterpreted by him as changes in altitude or distance.

When the aircraft gradually enters a thick fog, the lights will seem to become weaker and weaker. At this time, the pilot will feel as if the aircraft is gaining altitude. In an attempt to correct this, the pilot will sometimes by mistake lower his altitude excessively [8, 15].

On the other hand, when the lights appear to become gradually brighter and brighter, the pilot will feel as if the aircraft is descending or coming near the ground.

7. Obstacles due to glare of lights.

When the lights on the ground are too bright, they will give a sense of glare to the pilot's eyes and will impede recognition of the object which he is trying to sight [2, 15].

The seeming brightness of a light is not determined only by the luminous intensity of the light source. It increases or decreases in indirect proportion to the square of the distance 774 between the eyes and the light source. It is further attenuated also by the atmosphere present between them. For this reason, a

light which was seen only faintly in the upper sky sometimes may suddenly increase its glare when seen from the lower sky.

Furthermore, lights which do not seem glaring to eyes which are not accustomed to the dark will seem glaring when eyes which are accustomed to the dark are exposed to them.

8. Illusions of altitude accompanying changes in the size of the runway.

Differences in width and length of the runway have an influence on the judgement of altitude when the pilot is looking down from the upper sky. The influence is especially great when there are changes in the width.

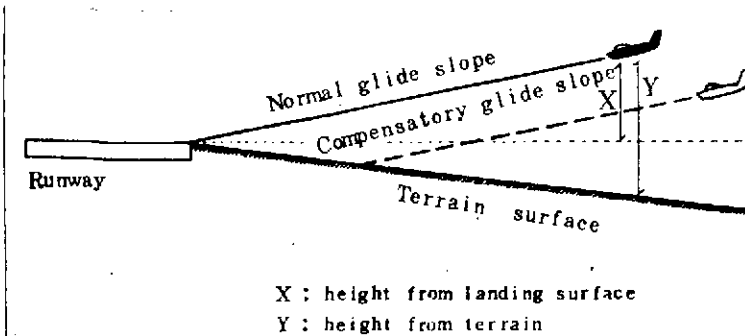
Even when viewed from the identical altitude, a runway with a broad width will make it appear that the altitude is higher. Therefore, there is danger that a pilot will fall into overshooting or undershooting in an attempt to correct this [7, 8, 12].

There are cases when pilots have fallen into such illusions and suffered undershoot accidents when they attempted to land at small airports to which they were not accustomed [3].

9. Illusions of altitude accompanying inclination of the terrain surface.

A pilot's judgement of altitude is influenced not only by the way the runway looks, but also by the inclination of the terrain surface in the flight path. An example of this is shown in Fig. 2, where the terrain surface in front of the runway gradually slopes downward. In such cases, there is danger that the pilot will adopt an excessively low approach altitude and will fall into undershooting [7, 8].

### III. Differences Between Instrument Landing and Visual Landing



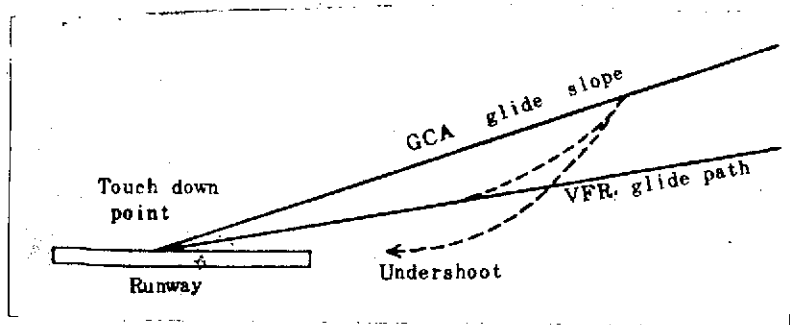
When an aircraft is landed visually, its angle of approach will differ according to the type of aircraft or the manner of flight. However, a quite shallow angle is usually adopted in the final stage in

order to alleviate the impact of contact. In cases where actual measurements have been made, when the plane comes into contact with the ground about 1000 feet from the end of the runway, the wheels of the airplane pass over the end of the runway at an altitude of about 30 feet or less. The angle of the glide pass is 2 degrees or less [4, 5].

In precision instrument approach by GCA, the aircraft is guided in over a glide pass with an angle of about 2.5 degrees with respect to the ground contact target points.

When a high-quality jet aircraft is guided in by precision instruments by GCA and goes into pull-out operations with the same angle, the aircraft will proceed too far. There are experimental data indicating that such an aircraft may touch down at a distance of 1000 feet or more away from the target point [1].

In the present methods of instrument landing, even when the precision instrumental approach system is adopted, in the final stages of pull-out operations and touchdown, the pilot must rely on visual judgement. If a pilot landing instrumentally



attempts to touch down at the target point set by GCA, he must first sight the runway, then descend from his previous precision instrument course of approach and shift to the same course as in visual landing (Fig. 3).

At this time, the altitude will seem to be too high, and the pilot will tend to decrease the output abruptly [14]. There is a great danger of undershooting when an abrupt descent ratio is adopted unnecessarily without forming an accurate idea of the altitude and the distance. Therefore, output controls and steering must be performed with great care [10, 13, 14].

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